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NAVY DEPARTMENT

BUREAU OF AERONAUTICS

WASHINGTON, D. C.

RESEARCH DIVISION REPORT NO. DR-1649 (U)

A PRELIMINARY STUDY OF A NUCLEAR-POWERED AEW AIRSHIP (U)

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A PRELIMINARY STUDY OF A NUCLEAR POWERED AIRSHIP

Report No. DR-1649

BuAer | May 1954 | Navy Dept

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SUMMARY AND RECOMMENDATIONS

An exploratory study has been undertaken of a nuclear-powered AEW airship which could remain on station for 100 hours. It turned out to have a volume of 2,000,000 cubic feet and to be powered by two specially modified T-56 gas turbine engines. Outside of the technical difficulties associated with the nuclear propulsion system, there also may be unusual problems which were not uncovered in this brief study.

A comparison of the preliminary figures obtained on nuclear powered AEW flying boats (reference 1) and airships is revealing for the same endurance.

Type	Airship	Flying Boat
DR Design No.	131	127a
Gross Weight, lbs.	120,000	270,000
Crew	30	20
Military Load, lbs.	30,000	27,000
Cruise Speed, kts.	100	180
Cruise Altitude, ft.	10,000	20,000

In the matter of crew comfort the AEW airship has definite advantages over an AEW seaplane.

It is recommended that more detailed studies should be conducted particularly to determine the relative advantage of the rigid, semi-rigid and blimp types for the envisioned size and type of mission. It is also worthwhile to undertake a more detailed study of the powerplant system.

DISCUSSION

In order to just touch the high points, it was necessary to make some rather broad assumptions to determine the feasibility of a nuclear powered AEW airship. The first of these was necessitated by a number of concentrated weights which have to be carried. It was assumed that a rigid airship would be more structurally efficient than a blimp. Secondly it was assumed that by keeping the crew as far as possible from the reactor, the weight of the reactor shielding could be appreciably reduced.

It was originally intended to use stern propulsion but this would introduce very serious balance problems unless the reactor were moved forward. Moving the reactor forward would bring about large heat losses between the reactor and powerplant. The stern propulsion system was therefore reluctantly abandoned at this time, and a more conventional arrangement accepted.

The chart of Figure 1 was prepared in order to provide an insight into the size of the proposed airship. This shows the weight empty (less powerplant and electronics) of the three principal Navy rigid airships. A military load of 20,000 lbs. was added to the weight empty curve with the remainder to be taken up by the powerplant. With a volume of 2 million cubic feet about 40,000 lbs. would be available for the powerplant.

A 2 million cubic foot rigid airship would require about 4000 h.p. to drive it at 100 knots. Assuming large diameter propellers of 90% efficiency, the total power available would need to be about 4,500 h.p. This could be met by two T-56 gas turbines modified for nuclear propulsion. A second weight estimate was therefore prepared, which indicated that the powerplant would weigh about 30,000 lbs. as may be seen on page 8. The basic weight empty was increased 10,000 lbs. to allow for the increased loads due to speeds higher than used in the design of the older rigid airships, and because of the loads due concentrated weights. At the same time, the military load was increased to 30,000 lbs. giving a deadweight of 120,000 lbs. There would be 110,000 lbs. of static lift and 10,000 lbs. of dynamic lift.

There were several reasons behind the choice of a 100 knot cruise speed. First it is approximately twice the present cruise speeds which should make the nuclear powered airship very much less dependent on weather conditions. Secondly it is not far above the present maximum speeds and so does not represent too much extrapolation of the present state of design knowledge. Thirdly from a power standpoint 200 knots would be conceivable but this would introduce a host of structural problems and undoubtedly have a very deleterious effect on the structural weight and therefore the size. Since the main purpose of the airship would be to remain on a given station without too much regard to the weather conditions, 100 knots appeared to be adequate. Further, it seemed reasonable to assume that structural methods and materials have improved sufficiently in the last quarter century so that the airframe could be now built for a 100 knot airship for not too much more weight than used to be required for a 70 knot airship.

The dimensions of airship were calculated assuming that it was formed by a body of revolution based on rotating the NACA 66_4021 airfoil about its chord line. A length of 510 feet was required to get the desired volume of 2,000,000 cubic feet. During the preliminary layout, it was decided to remove the cusp inherent in this series of NACA airfoils aft of station 60. This gave a little additional volume which, while not calculated, would probably compensate for the space occupied by the radar antenna, cabin and powerplant. No attempt was made to work out the balance of the airship. Because there are two large concentrated weights it should not be troublesome. As shown on BuPlan 54A119H1* there is 180 feet between the back of the cabin and the front of the reactor. This was accomplished in part by using a double deck cabin. The distance is so large that the cabin is unshielded and all the necessary shielding is concentrated at the reactor. Detail studies might show that there would be weight advantages to splitting the shielding, but this has been left to the future.

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*BuPlan 54A119H1, "Nuclear Powered AEW Airship" should be considered as a part of this report.

Because crew fatigue does not appear to be a serious problem, it might be worthwhile to consider 200 hour flights. The feasibility of such flights appears to be controlled by the radiation dosage to which the crew would be exposed and possible contamination of the nuclear fuel. Since both require detailed studies of the powerplant, the endurance on station has been assumed to be identical with the nuclear-powered AEW flying boats presented in reference 1, namely 100 hours.

A detailed study of the powerplant and operational possibilities of a nuclear powered AEW airship is in the course of preparation. It would not be premature, however, to make some preliminary remarks comparing nuclear powered airships and flying boats for an AEW mission. In reference 1, a relationship is shown between crew space requirements and endurance. According to that chart, there should be at least 260 cubic feet of cabin per man for 100 hour endurance in a heavier-than-aircraft. For a 30 man crew this means 7,800 cubic feet and a little more than this has actually been provided in the proposed airship. The space comparison is not entirely fair because it is considered that flight in the airship should be much less fatiguing. Noise and vibration should be almost entirely absent and further the entire area forward of the cabin could be used for exercise.

If the airship can cruise at 100 knots it should be nearly independent of weather conditions and be able to remain on station. The proposed airship will carry sufficient crew and gear so that it should be able to perform an effective AEW mission. According to reference 1, the minimum AEW airplane would have a gross weight of about 270,000 lbs. An airplane with a gross weight of 350,000 lbs. would have somewhat similar crew space and comfort as the rigid airship.

The speeds of both the nuclear-powered airship and airplane are very low compared to modern fighters. The airship would be at some defensive disadvantage because of its decreased maneuverability and increased visibility over the large low speed flying boat.

Present day blimps powered with internal combustion engines can have endurances well in excess of 100 hours. Their big disadvantage is that the long endurance is performed at such a low speed that the craft is at the mercy of the vagaries of the weather. By raising the cruising speed to 100 knots, the primary difficulty would be almost entirely overcome.

For AEW missions it is desirable to operate at as high an altitude as feasible. The airship can be operated at altitudes over 20,000 feet, though it is quite doubtful that this would be very desirable unless the cabin were pressurized. There may also be winds at such altitudes with which the airship could not conveniently cope. It is thought that until more detailed studies are carried out, the nuclear powered airship should be considered to operate altitudes below 10,000 feet. It might be noted in passing, however, that the nuclear powered airship may be inherently less altitude limited than the nuclear powered flying boat.

A nuclear powered airship would undoubtedly have some special handling problems. On the surface, at least, they do not appear to be any more difficult than the problems that will be encountered in handling nuclear powered heavy-than-aircraft.

REFERENCE

1. Locke, F.W.S., Jr.: "A Preliminary Study of a Nuclear-Powered AEW Seaplane", NAVAER DR Conf Report No. 1554, July 1953

WEIGHTS, DR-131

First Estimate

Basic Weight Empty*		50,000 lbs.
Military Load		20,000 lbs.
Powerplant		40,000 lbs.
Static Lift		110,000 lbs.

Second Estimate

2 Modified T-56 with special gearing	4,000 lbs.	
2 Propellers	2,000 lbs.	
Reactor @ 5 lbs/HP	22,500 lbs.	
Extra Insulation	1,500 lbs.	
Powerplant		30,000 lbs.
Basic Weight Empty*		60,000 lbs.
Military Load		30,000 lbs.
Deadweight		120,000 lbs.
Static lift		110,000 lbs.
Dynamic lift		10,000 lbs.
Total Lift		120,000 lbs.

*Basic weight empty includes everything except powerplant and military load.

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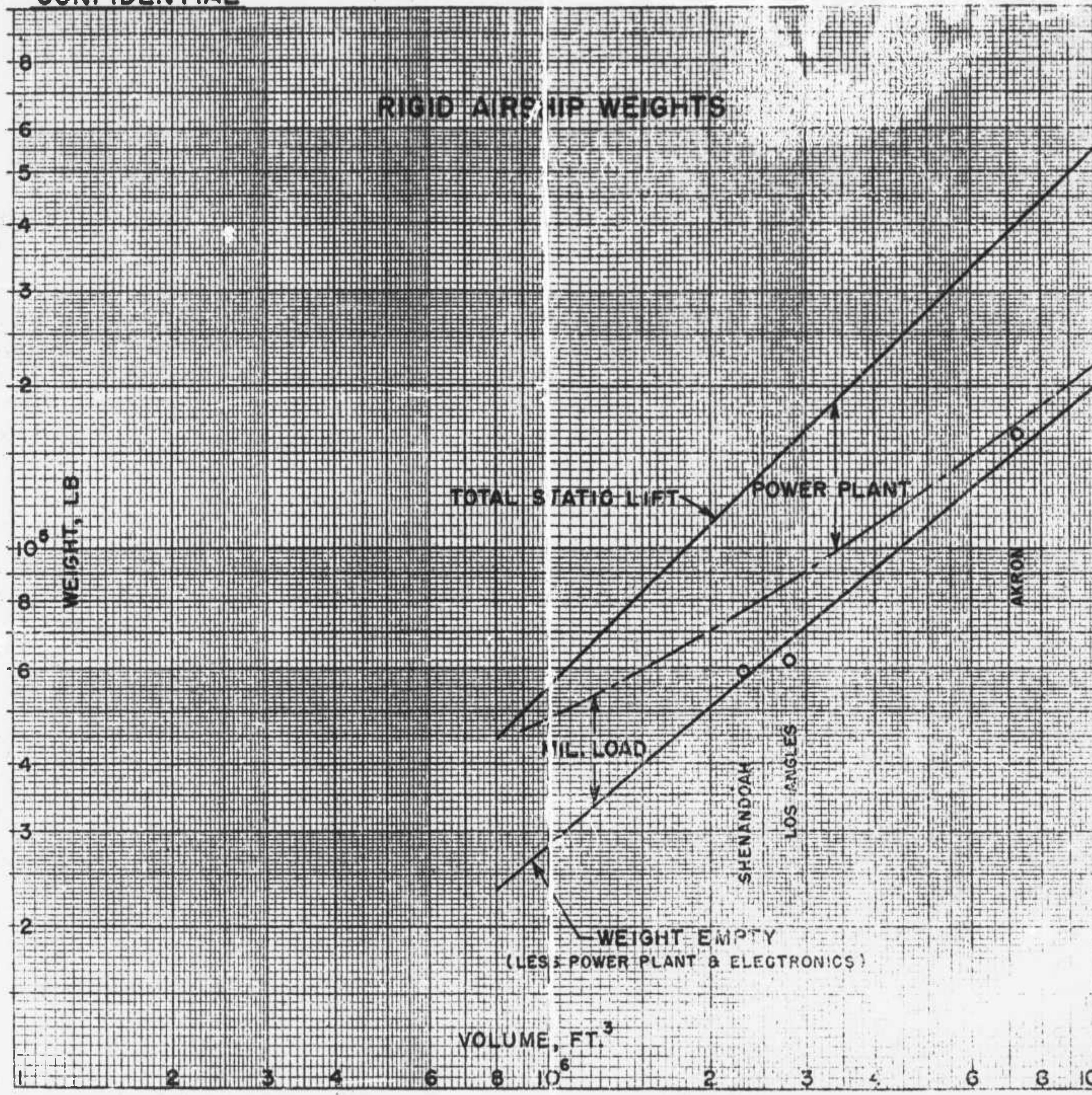

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